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A Contextualized Curricular Supplement for Developmental Reading and Writing

Two experiments were conducted with developmental education students to investigate the impact of a contextualized intervention focusing on written summarization and other reading and writing skills. In experiment 1 (n = 322), greater gain was found for intervention than comparison participants on three summarization measures: proportion of main ideas from the source text, accuracy, and word count (ES = 0.26–0.42). In experiment 2 (n = 246), results were replicated for several summarization measures (ES = 0.36–0.70), but it was also found that intervention participants copied more from the source text at posttest than did the comparison group. Further, intervention participants using science text outperformed students receiving generic text on two summarization measures (ES = 0.32–0.33), providing moderate support for contextualization.

The overarching purpose of developmental education is to enable academically underprepared students to benefit from the postsecondary curriculum. An important part of developmental reading and writing education is instruction in the literacy skills needed in college-level disciplinary courses (Brockman, Taylor, Kreth, & Crawford, 2011). Different content areas involve unique vocabulary, organization of text, and styles of expression, creating special, discipline-specific reading and writing demands (Beaufort, 2004; Haas, 1994; Shanahan, Shanahan, & Misischia, 2011). One way to prepare developmental students for college-level discipline-area reading and writing demands is to contextualize developmental instruction in the specific types of text they will encounter in content courses. Discussion with developmental instructors (Perin & Charron, 2006) as well as examination of developmental textbooks (e.g., McWhorter, 2010) suggest that, although content-area text is often used in developmental education, especially in basic reading courses, themes and tasks are varied. This approach gives students a sampling of what is to come, but not experience of the sustained reading and writing in one subject area they will need once in a college-credit disciplinary course. Developmental education instructors can provide such practice by contextualizing skills in a selected discipline.

Contextualization has been defined as "a diverse family of instructional strategies designed to more seamlessly link the learning of foundational skills and academic or occupational content by focusing teaching and learning squarely on concrete applications in a specific context that is of interest to the student" (Mazzeo, Rab, & Alssid, 2003, pp. 3–4). This approach is also known as embedded instruction, anchored instruction, integrative curriculum, theme-based instruction, and infused instruction. College educators consider contextualization of basic skills useful (Baker, Hope, & Karandjeff, 2009; Boroch et al., 2007), and several empirical studies in higher education suggest positive effects (Caverly, Nicholson, & Radcliffe, 2004; Martino, Norris, & Hoffman, 2001; Perin, 2011; Snyder, 2002). Further, the contextualization of reading and writing instruction is an approach that would help students meet the Common Core State Standards for English Language Arts and Literacy, which include reading and writing in the disciplines (National Governors' Association and Council of Chief State School Officers, 2010).

Contextualization may help academically underprepared students overcome several difficulties, including limited transfer of skill (Carnine & Carnine, 2004; Tai & Rochford, 2007), low motivation (Burgess, 2009; Dean & Dagostino, 2007), and limited background knowledge (Diakidoy, Mouskounti, & Ioannides, 2011). Contextualized instruction creates similarities between the contexts of instruction and application, which in turn can promote generalization of skill (Stone, Alfeld, Pearson, Lewis, & Jensen, 2006). Further, developmental education may be more motivating to students if instructors use disciplinary text that students know is typical of material assigned in concurrent or future content courses required for degree completion. In addition, sustained experience with text in a specific content area may result in implicit learning of disciplinary concepts, which can create the background knowledge that is essential for reading. For these reasons, improvement of reading and writing skills based on extended exposure to discipline-specific text in selected content areas may lead developmental students to apply the acquired skills in college-credit content courses.

Although contextualization has strong advocates (Baker et al., 2009; Johnson, 2002), its benefits as an intervention have rarely been directly tested (Perin, 2011). This paper reports findings for a contextualized intervention, the Content Comprehension Strategy Intervention (CCSI), a semester-long curricular supplement designed to give community college students attending upper-level developmental reading and writing courses sustained practice in basic reading and writing skills in the context of science text. The science domain was chosen because failure rates tend to be high in community college science courses, which impedes college graduation; further, discussion with community college science instructors suggested that difficulty in reading course textbooks was an important factor in failure rates.

Purpose and Questions

This study investigated outcomes associated with participation in the CCSI, which emphasized written summarization and also involved defining vocabulary, formulating questions, taking reading comprehension quizzes, and writing short opinion essays. Two quasi-experimental studies, each lasting one college semester, were conducted with groups of students enrolled in developmental education. In the first experiment, the CCSI was contextualized in science text, and outcomes were compared with those in a comparison group receiving the same developmental education curriculum but no intervention. The second experiment, conducted in a subsequent semester with different students taking the same courses, replicated and expanded upon the first experiment by randomizing participants to the science text condition or a generic text condition, and comparing performance in each group to that of a comparison group. Both experiments statistically controlled for site, science knowledge and interest, and student demographics to ensure that there was no confound between these variables and the effects of the intervention itself.

The following questions were asked in experiment 1: (1) Is participation in an intervention providing contextualized practice in reading and writing associated with better summarization than "business-as-usual"? (2) Does reading comprehension ability, as measured by the written summarization task, transfer to a standardized reading test? Experiment 2 asked (1) Are results for the first experiment replicated with a different sample? (2) Does the impact of the supplemental practice differ depending on whether it is contextualized in a specific discipline, or generic?

Method

Participants and Setting

There were $n = 322$ participants in experiment 1 and $n = 246$ in experiment 2. The students attended two community colleges, referred to here as College 1 and College 2, situated in large cities on the East and West Coasts, respectively. All students attended an upper-level developmental reading or English course, which was one level below the first level of college-credit English or freshman composition. Instruction focused on skills such as using context clues and word analysis to understand text and improve vocabulary; previewing, identifying main ideas and supporting detail; identifying an author's purpose, understanding figurative language, analyzing elements of fiction, and use of grammar, punctuation and text structure in writing.

A purposive sample of 16 developmental education classrooms was recruited for each experiment, and in both experiments, 12 of the classrooms received the intervention and four served as a comparison. The classes in each condition were divided evenly between the two sites. The instructors of these classes were recruited based on willingness to participate, and all had at least five years of experience in teaching developmental education. Student background variables are shown in Table 1. Ranges for race/ethnicity, gender, and college attendance over the two experiments were 34–37% Hispanic, 9–20% Black, 55% female, and 60–68% attending full time. Mean ages were 20–21 years (SD 4.75–6.02), although 67–70% were aged 18 years and younger, suggesting that participants were essentially a sample of students who had recently completed secondary education.

Intervention

The CCSI consisted of ten units, each of which followed the same steps in the same order: (1) activate prior knowledge by answering a question based on the title of the reading passage prior to reading it; (2) read a textbook passage; (3) check off items on a reading comprehension strategy checklist to indicate strategies used while reading; (4) select two words from a list of five technical terms (e.g., reactivity, anaerobic) or more general vocabulary (e.g., substance, matrix) from the text, look them up in a paper or online dictionary, copy the definition that fits with the passage, and then "write one sentence to explain the word to a friend;" (5) answer a self-efficacy question (Kitsantas & Zimmerman, 2009); (6) prepare to write a summary of the reading passage by answering a series of questions focusing directly on main ideas explicitly stated in the passage; (7) write the summary; (8) answer a self-monitoring question about whether all the information from the prior answers to the main idea questions had been included in the summary, whether other ideas were included, whether the student's own words had been used, and whether the student had reread and corrected the summary; (9) formulate a question that an instructor might ask in class about the passage and then answer the question (Rosenshine, Meister, & Chapman, 1996); (10) take a 3-question multiple-choice reading comprehension quiz based on the passage; (11) write one or two paragraphs expressing an opinion on a controversy related to topic of the reading passage (De La Paz, 2005; Ferretti, Lewis, & Andrews-Weckerly, 2009; Osborne, 2010; Schultz, 2003); and finally, (12) judge the quality of the opinion writing sample using a 6-point holistic rubric.

In experiment 1, the CCSI was contextualized in reading passages on science, and all practice related to the selected passages. Experiment 2 added a second condition, using generic text, and CCSI participants were randomly assigned within classrooms to science and generic conditions. All reading passages were drawn intact from existing textbooks. The science passages were on anatomy and physiology. Pilot testing and discussion with instructors indicated that college-level text was too difficult for the students because they had little prior knowledge of the content (Lei, Rhinehart, Howard, & Cho, 2010). Consequently, the 10 units in the science condition were developed as five yoked pairs. The first unit of each pair presented a middle school level reading passage and the second unit of the pair used a passage on the same topic from the introductory level community college textbook used in the pilot study. Thus, the odd-numbered passages in the sequence of intervention units were from middle school textbooks and the even-numbered passages were on the community college level. It was expected that background knowledge and vocabulary would be developed using the easier text, which would then be applied to understanding the more difficult college-level text. The five yoked topics in the science condition were matter and energy, atoms, the heart, blood, and respiratory system functions. The easier text was provided for review at the beginning of each even-numbered (college-level) unit.

The generic reading passages used in experiment 2 were on an assortment of themes and were drawn from textbooks similar to, but not the same as, those used in the participants' developmental education classrooms. These passages were on the following topics: genetic testing, entrepreneurship, censorship, drug addiction, the social consequences of air conditioning, the social role of news media, cosmetic surgery, participation of African Americans in baseball, youth hazing, and the founding of Liberia. The text was selected for its approximate match of word count with the science text.

Over and above their regular developmental education coursework, CCSI participants were asked to complete one intervention unit per week for ten weeks, independently and on their own time. Thus, the intervention was not taught, but involved weekly supplementary practice in basic reading and writing skills. This independent, out-of-class practice substituted for a portion of regular homework, which was assigned to the comparison group. CCSI participants received course credit for completing the intervention units and in the comparison group, homework counted toward course achievement according to instructors' typical procedure.

Comparison Condition

Students in the comparison group, which was business-as-usual, followed the same developmental education curriculum as the CCSI participants and their only involvement with the project was to take the same pre- and posttests as CCSI participants. The instructors verified that none of the homework or instruction in the comparison classrooms related to the CCSI subject matter.

Measures

The study focused on the relation between CCSI participation and gain in written summarization skill. Summarization was measured using five variables from a task called the Science Summarization Test designed for this study. To control for preexisting knowledge of, and interest in, reading about science, two pretest measures—the Science Knowledge Test and the Science Interest Inventory (available from the first author)—were also developed by the researchers. Also, the Nelson-Denny Reading Test (Brown, Fishco, & Hanna, 1993) was administered as a transfer task. This measure was selected because it assesses general rather than content-specific reading skills, and has been used in previous research with developmental readers (Hart & Speece, 1998). Student age, gender, and race/ethnicity, and college attended were entered as control variables.

Science Summarization Test. The Science Summarization Test (available from the first author) was a 30-minute researcher-designed task in which participants read a passage drawn from an introductory college anatomy and physiology textbook and wrote a summary with the text present. The instructions (based on Armbruster, Anderson, & Ostertag, 1987) were provided in writing and read aloud by the instructor; students were directed to write a one- or two-paragraph summary that contained the important information in the passage. The instructions defined a summary as "a statement mostly in your own words that contains the important information in the passage." Alternate forms A and B were developed, and administration was counterbalanced to avoid text-specific effects. Form A consisted of 447 words, Flesch-Kincaid readability was 11.5, and Lexile score was 1300L. Form B contained 453 words, Flesch-Kincaid readability was 13.8, and Lexile score was 1370L. The topic of Form A was the nervous system and the topic of Form B was homeostasis. None of the information presented in these two reading passages overlapped with topics used in the intervention.

The five dependent variables obtained from the test were the proportion (i.e., percentage) of main ideas from the source text (Perin, Keselman, & Monopoli, 2003), the accuracy of information of the ideas expressed in the summary (Frey, Fisher, & Hernandez, 2003), word count, conventions (grammar, punctuation, and spelling), and the ability to paraphrase rather than copy information from the source (Keck, 2006). Although derived from the same task, most of the correlations among the scores in the two samples were weak, suggesting that discrete phenomena were being measured. There were only two correlations above $r = .4$, the proportion of main ideas and word count ($r = .48$, $p < .01$), and proportion of main ideas and accuracy ($r = .46$, $p < .01$), both of which occurred in the second experiment (see Table 2 for correlations).

The accuracy of information in the written summary was measured on a 4-point scale, following a rubric reported by Frey et al. (2003). Word count was a simple count of the number of words written. Students' use of conventions, defined as grammar usage, punctuation, and spelling, was measured on a 4-point scale, also using Frey et al.'s (2003) rubric. The paraphrasing measure was a 2-point scale on the extent to which the summary was written in the student's own words (Perin et al., 2003), defined as "restating the ideas of a given excerpt without borrowing too liberally from the language of the original" (Keck, 2006, p. 262). Scoring criteria for the accuracy, conventions, and paraphrasing measures are provided in a technical report on this study (Perin, Bork, Peverly, Mason, & Vaselewski, 2012). All protocols were scored by trained project assistants. A research assistant experienced in writing assessment but unfamiliar with the goals of the project scored a random sample of 25% of the written summaries. Inter-rater reliabilities were $r = 0.92$ for proportion of main ideas and $r = 0.96$ for word count. Interscorer agreements were 90% for accuracy, 85% for conventions, and 83% for paraphrasing.

Nelson-Denny Reading Test. The Nelson-Denny Reading Test consists of a 15-minute, 80-item multiple-choice vocabulary subtest, and a 20-minute reading comprehension subtest containing

38 multiple-choice factual and inferential questions based on seven reading passages on a wide variety of topics. Scores on the two subtests are summarized in a total score. Scaled scores were derived using tables in the test manual, taking the first year of college as the reference. Because the vocabulary and reading comprehension subtest scores were highly correlated with each other and with the total score, only the total score was used. Form G was administered at pretest and Form H at posttest.

Science Knowledge Test. The Science Knowledge Test consisted of 20 multiple-choice items, representing key information from each of the 10 CCSI units (two items from each unit). The questions were reviewed for coherence and suitability by an English professor with 10 years of experience in community college teaching and piloted with two female adults (ages 22 and 24) with community college associate degrees. Also, a draft of the measure was reviewed by a panel of instructors from developmental education and science at a community college where the study was piloted. A descriptive analysis was completed with data from 765 study participants who took the test during the pretest administration in experiments 1 or 2, irrespective of whether they completed the intervention or the posttest. Results indicated that assessment scores were normally distributed ($M = 10.76$, $SD = 2.75$).

Science Interest Inventory. Students' interest in science was evaluated using a 10-item task based on prior research on the Motivation for Reading Questionnaire (MRQ) (Mason, 2004; Wigfield & Guthrie, 1997) and reading comprehension (Mason, 2004). A four-choice Likert-type scale format was used based on the MRQ. Students were asked to respond to statements such as "I enjoy learning about different science topics" by placing an "X" on the response that best expressed how they felt, ranging from 1 (very different from me) to 4 (a lot like me). Following the MRQ, interest covered reading curiosity, which reflects the desire to learn; reading involvement, which reflects the pleasure gained when learning something of interest; the importance of reading or subjective task value; and work avoidance, which reflects what students do not like about a topic. In the current task, MRQ items were modified to reflect the topic of science, participants' educational level, and the context of a community college.

Procedure

In each experiment, data were collected over 11 weeks of one semester, including both pre- and post testing and completion of the intervention. Early in the semester, each participating instructor introduced the project, recruited students, and obtained signed consent. The pretest was administered two weeks into the semester in both CCSI and comparison classrooms. In the CCSI classrooms, immediately after the pretest, the first intervention unit was distributed. In each subsequent week, the instructor collected the previous week's unit and distributed the next one. In the 11th week, when the 10th unit had been collected, the posttest was administered in both CCSI and comparison classrooms. All tests were administered by the classroom instructors.

Analytic Strategy

To assess pre-post gain in the intervention versus comparison group, the post scores on the dependent variables from the Science Summarization Test and the Nelson-Denny Reading Test were compared between groups using OLS regression with an analysis of covariance (ANCOVA), controlling for pretest scores. Science knowledge, science interest, and student background variables were also included in the analyses if they were found to be significantly correlated with the outcome measure.

Five analyses were performed for the dependent summarization variables: (1) the proportion of main ideas from the source text that were included in the summary, (2) word count, (3) the accuracy of information in the summary, (4) writing conventions, and (5) the extent to which information from the source text was paraphrased rather than copied. All scores were *z*-scores ($M = 0$, $SD = 1$). Another analysis was conducted on the Nelson-Denny total scores, using scale scores transformed from raw scores using tables provided by the publisher ($M = 200$, $SD = 25$).

Step 1 of each model adjusted for all background variables (science knowledge, science interest, and student background variables) found in prescreening to be related to the dependent variable, site of data collection, and pretest score. Step 2 introduced group status (1 = intervention; 0 = comparison) to determine whether the posttest scores varied by group, controlling for the scores used in Step 1. The regression weights are measures of effect size in predicting standardized posttest scores from group, standardized pretest scores, site of data collection, and background characteristics. Standardized beta weights were used as measures of effect size. Since the paraphrasing score was on a 2-point scale, this variable was analyzed using logistic regression; however, the method was identical to the OLS regression framework used in the other analyses. There were no statistically significant group differences in either experiment on the pretest summarization or reading measures or on the science knowledge, science interest, or student background variables.

Results

Experiment 1

The unadjusted pre- and posttest means and standard deviations for the five written summarization variables and the Nelson-Denny total reading score are displayed in Table 3. On the Science Knowledge Test (maximum score = 20), the mean score was 10.51 ($SD = 2.56$). On the Science Interest Inventory (maximum score = 40), the mean score was 26.65 ($SD = 5.4$).

The results of the OLS regression with ANCOVA are summarized in Table 4. For the written summarization measure, post scores were compared for the intervention and comparison groups on main ideas, word count, accuracy of information, conventions, amount of paraphrasing, controlling for pretest score control, site, and background variables (science knowledge, science interest, and student characteristics). Students who participated in the intervention included one third of a standard deviation more main ideas than the comparison group (ES = 0.34, $p < .01$), and wrote two fifths of a standard deviation more words than the comparison group (ES = 0.42, $p < .01$). The CCSI group's posttest accuracy scores were one quarter of a standard deviation higher than those of the comparison group, controlling for pretest scores and site of data collection (ES = 0.26, $p < .05$).

However, participation in the CCSI was not a statistically significant predictor of post scores on the conventions measure. For the paraphrasing variable, the overall model fit of the predictors (pretest score, site, science knowledge, science interest, and intervention condition) was very weak (–2 Log Likelihood = 347.59). The model correctly classified 68.6% of the cases but did not significantly predict group membership. Finally, CCSI participation was not a statistically significant predictor of the transfer measure (posttest Nelson-Denny total scaled scores).

Experiment 2

Table 5 shows the unadjusted pre- and post scores for the five summarization variables and the Nelson-Denny total scaled score for Experiment 2. Similar to Experiment 1, on the Science Knowledge Test (maximum score = 20) the mean score was 10.82 (SD = 2.90), and on the Science Interest Inventory (maximum score = 40) the mean score was 27.06 (SD = 5.45).

Participation in the CCSI was associated with gain on several written summarization variables, but not on the transfer measure (see Table 6). Students in the CCSI science text condition included over one half of one standard deviation more main ideas from the source text in their summaries, compared to students in the comparison group (ES = 0.62,

$p < .001$). Students in the CCSI generic text condition also included more main ideas compared to students in the comparison group (ES = 0.36, $p < .05$). Compared to the comparison group, science text participants wrote 0.70 SD more words ($p < .001$), and generic text students wrote 0.62 SD more words than the comparison group ($p < .001$). The science text group's posttest accuracy scores were 0.44 SD higher than those of the comparison group ($p < .05$). However, gain on posttest accuracy was not different in the generic text and comparison groups. The outcome for the conventions measure was similar for the experimental and comparison groups.

On paraphrasing, the overall model fit of the predictors (pretest score, site, science knowledge, science interest, and intervention condition) was weak (–2 Log Likelihood = 227.679), but was statistically reliable in distinguishing posttest scores $\chi 2 = 8.46$, $p < .05$). The model correctly classified 73.4% of the cases. The comparison group was four times more likely to summarize the source text in their own words than the science group. Thus, the posttest summaries of the science group showed a greater increase in the amount of copying from the source text than the comparison group. There was no difference between the comparison and generic conditions on this variable. In addition, intervention participation did not predict gain on the Nelson-Denny transfer measure.

Comparison of Text Conditions

To understand the impact of contextualization, we compared differences in posttest scores for the science and generic groups directly, and removed the comparison group from the analysis (see Table 7). Controlling for pretest, site, and background characteristics, students receiving the science text included one third of a standard deviation more main ideas in their summaries than CCSI students in the generic text condition (ES = 0.32, $p < .05$). Controlling for pretest scores, site, and background characteristics, the science text group's posttest accuracy scores were 0.33 of a standard deviation higher than those of the generic text group ($p < .05$).

Discussion

The present research found that participation in a supplement to developmental education curriculum that emphasized written summarization, and also provided practice in vocabulary, question generation, reading comprehension questions, and persuasive writing, was associated with gain on several aspects of written summarization. In two experiments, students participating in the intervention showed greater gain than a business-as-usual comparison group on the proportion of main ideas from source text, accuracy of information, and word count of written summaries. In addition, students who practiced developmental skills using a science text demonstrated stronger performance than students using a standard generic developmental education text on the inclusion of main ideas and accuracy of written summaries of science topics.

Controlling for science knowledge, science interest, site, and background variables, intervention participants gained more than comparison groups on inclusion of main ideas, accuracy of information, and word count in summaries of dense, expository text on science topics, with effect sizes of 0.26 to 0.70. Moreover, in the second experiment, two of the effect sizes were relatively high: main ideas of the intervention versus comparison group (ES = 0.62) and word count of the summaries written in both the science and generic conditions versus the comparison condition (ES = 0.70 and ES = 0.62, respectively).

There is not a robust body of research on summarization interventions with low-skilled adults that can be used to evaluate the size of these effects. However, previous literacy intervention studies with underprepared college students have reported effect sizes of d = 0.31–0.92 (Caverly et al., 2004; Friend, 2001; Hart & Speece, 1998; Selinger, 1995; Snyder, 2002; Spring & Prager, 1992). Intervention research in secondary education found effect sizes for summarization of d = 0.57–0.77 (Reynolds & Perin, 2009), and a meta-analysis on secondary education writing interventions found a mean weighted effect size of 0.82 for summarization (Graham & Perin, 2006). The current effects tend to be low to moderate compared to those reported previously.

The present findings corroborate earlier studies describing underprepared college students' considerable difficulty with summarization (Johns, 1985; Perin et al., 2003; Selinger, 1995). Although statistically significant gains were obtained in the present research, it is notable that after one semester in an upper-level developmental education course supplemented with an intervention emphasizing written summarization, the students included in a written summary an average of only about half of the key ideas in a reading passage from an introductory college science textbook. Further, the mean Nelson-Denny Reading Test posttest scores of 184 and 186 in the two experiments were below the test mean of 200, suggesting that students remained underprepared for college reading. However, despite some limitations discussed below, the research points to an approach that can enhance the preparation of low-skilled students for the literacy demands of the postsecondary curriculum.

Role of Background Knowledge in Summarization

As a measure of reading comprehension (Graham & Hebert, 2010), summarization is subject to the effects of prior knowledge (McKeown, Beck, Sinatra, & Loxterman, 1992). The science knowledge measure indicated that the students had limited background knowledge of the science topics they were being asked to summarize. However, this does not seem to be the only explanation for the difficulty. Johns (1985) and Selinger (1995) also reported similar problems using generic text in earlier studies. Our results, in combination with the previous research suggest that while summarization enables learning from text (Armbruster et al., 1987), given that this skill is also vulnerable to the effects of prior knowledge, it is important to strengthen background knowledge at the same time as teaching summarization skills to underprepared students. In this case, courses that systematically link developmental skills and content knowledge may be particularly effective in preparing students for college reading and writing.

Paraphrasing Source Text When Summarizing

Substantial amounts of copying directly from the source text were observed in this study using the paraphrasing measure (also see Keck, 2006; Perin et al., 2003). It appeared that the students improved in the ability to detect what was important in the source text, based on the improved scores on the proportion of main ideas from the text included in the summaries, but at the same time, in experiment 2, they copied more. This result suggests that the students' writing and/or reading comprehension skills did not keep up with their increase in sensitivity to important information in text. Thus, it is possible that the students receiving the intervention began to see what was important but could not state it in their own words. Young children tend to copy word-for-word when summarizing text, but by sixth grade use their own words (Hidi & Anderson, 1986). It is possible that the current sample had not made that transition because of difficulties with the act of summarizing itself or more general problems associated with low literacy skills and/or lack of prior knowledge of the topic. A future direction would be to investigate the relation between paraphrasing and the accuracy of the summaries. Although accuracy increased from pre- to posttest, the level of accuracy remained somewhat low (e.g., a mean post score of 2.99, *SD* 0.68, on the 4-point accuracy scale for participants in the science condition in the second experiment), even though the source text was present during summarization.

Potential Efficacy of Contextualization

This study suggests the potential efficacy of contextualization in finding positive effects on several measures of written summarization for students practicing with science versus generic text. Specifically, on several variables, students engaging in sustained practice in core reading and writing skills using text in the same subject area as the outcome measure outperformed students practicing the same skills with standard, generic text. As the field of developmental education seeks ways to improve the outcomes of academically underprepared students (Silver-Pacuilla, Miller, & Perin, 2013, in press), several implications for research and practice can be drawn from these results. The issue of contextualization needs further investigation, first in light of debates on the extent to which instruction should be general versus narrow in order to promote the transfer of skill (Anderson, Reder, & Simon, 1996; Bransford, Brown, & Cocking, 2000), and second, because the current study used only one measure relating to contextualization. A fuller explanation would be gained by using both generic and contextualized outcome measures. Additional research is also needed to track outcomes for underprepared students who have participated in contextualized developmental education interventions to investigate impact on performance in disciplinary courses. Further, the current intervention was provided as an out-of-class supplement to the regular developmental curriculum, and it would be important to learn whether the approach can be integrated with business-as-usual instruction to create opportunities for developmental reading and writing students to build discipline-specific literacy skills. In this vein, a further question arises as to the nature and amount of professional development that would be needed to support such an effort.

Several practical implications can also be drawn. For example, since students were shown to benefit from contextualized reading and writing practice, developmental instructors could provide such experience as routine course homework. This might be accomplished by surveying students regarding their degree and career goals, and then conferring with instructors in relevant discipline areas to identify appropriate text for such practice. This form of homework would provide practice in the same basic skills being learned in class, but applied to content that students would be expected to read and write about once in a college-credit content-area course. Perhaps the most important practical implication is that it is crucial that instructors and students be interested in this approach and believe it to be a direction worth trying.

Limitations

Only one subject area, anatomy and physiology, was used, so that the possible benefits of contextualization in other content areas were not evaluated. Participants' low levels of knowledge and interest in the relevant subject area were also limitations. Stronger effects of contextualization may be found if knowledge and interest are higher, based on theories that this approach is beneficial because it makes learning relevant to students' interests and needs (Johnson, 2002). Students may be interested in the goal of preparing for courses they need to graduate, but may lack interest in the specific subject areas that need to be mastered toward that end. Further, some of the positive findings in the study were attributable to pre–post declines in the comparison group (word count in both experiments, and accuracy in the first experiment). Although the declines suggest that the curricular supplement helped maintain intervention participants' skills as they proceeded through their developmental course, the declines may have been due to actual lowering of the skills tested or to lower motivation on the posttest.

Conclusions

The sample of students participating in this study were mostly low-achieving older adolescents and young adults who had completed secondary education in the U.S. Previous research suggests that community college developmental education instruction is limited in its effects (Bailey, 2009). Students enter with significant obstacles resulting from personal history and academic background (Cohen & Brawer, 2008; Levin, 2007), and the pedagogy traditionally used may not be compelling (Grubb et al., 1999). In this context, the positive results obtained in this research are notable. The findings indicate that although the students were low skilled, they could still improve in ways that promoted their future success in college-credit courses. The intervention included traditional academic literacy skills that are taught but not necessarily learned across the grade levels. Continued practice in these skills, contextualized in disciplinary content, seems to be a promising direction toward the preparation of academically underprepared students for the reading and writing demands of the postsecondary curriculum.

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Table 1

Experiments 1 and 2: Participant Background Characteristics: Percentage of Sample

	Experiment 1 (*n* = 322)			Experiment 2 (*n* = 246)			
Variable	Total Sample (*n* = 322)	Intervention (*n* = 249)	Comparison (*n* = 73)	Total Sample (*n* = 246)	Science (*n* = 97)	Generic (*n* = 97)	Comparison (*n* = 52)
Race/ethnicity							
White	33.1	34.5	28.2	21.1	26.8	17.5	17.3
Black	9.4	9.2	9.9	20.3	18.6	22.7	19.2
Hispanic	36.6	33.3	47.9	34.1	28.9	35.1	42.3
Asian	10.3	12.4	2.8	14.6	12.4	18.6	11.5
Other	10.6	10.4	11.3	9.8	13.4	6.2	9.6
Gender							
Female	54.7	55.0	53.5	55.3	55.7	56.7	51.9
Male	45.3	45.0	46.5	44.7	44.3	43.3	48.1
Status							
Part time	31.6	30.1	36.6	40.0	41.2	29.2	57.7
Full time	68.4	69.9	63.4	60.0	58.8	70.8	42.3
Age							
18 & younger	66.6	65.5	70.4				
19 & older	33.4	34.5	29.6				
19 & younger				57.3	58.8	61.9	46.2
20 & older				42.7	41.2	38.1	53.8

Table 2
Experiments 1 and 2: Intercorrelations Among Pretest Measures

Variable (Experiment 1)	1	2	3	4	5	6	7	8
Nelson–Denny								
1. Total Scale Score	1	.32***	.11*	.17***	–	.16**	.40***	.07
Science Summarization								
2. Prop. of Main Ideas		1	.18**	.22***	–.19**	.16**	.17**	–.02
3. Word Count			1	.13**	–.18***	–.06	.12*	.11*
4. Accuracy				1	–.36***	–.29***	.15**	–.04
5. Paraphrasing					1	.07	–	.02
6. Conventions						1	.09	–.15**
Background knowledge								
7. Science knowledge							1	.18***
8. Science Interest Inventory								1
Variable (Experiment 2)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
Nelson–Denny								
1. Total Scale Score	1	.19**	.15*	.11	.17*	.17*	.41**	.01
Science Summarization								
2. Prop. of Main Ideas		1	.48**	.46**	–.14*	–.03	.16*	.02
3. Word Count			1	.05	–.03	–.13*	.12	.05
4. Accuracy				1	.24**	.12	.04	–.02
5. Paraphrasing					1	.06	.10	.02

(**Table 2** *continued on following page*)

Table 2 *continued*

Experiments 1 and 2: Intercorrelations Among Pretest Measures

Variable (Experiment 2)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**
6. Conventions						1	.08	−.09
Background Knowledge								
7. Science Knowledge							1	.32**
8. Science Interest Inventory								1

Note. * $p < .05$. ** $p < .01$. *** $p < .001$.

Table 3

Experiment 1: Unadjusted Pre- and Posttest Scores

	Total Sample				Intervention Group				Comparison Group			
	Pretest		Posttest		Pretest		Posttest		Pretest		Posttest	
Measure	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Sci. Sum. Test												
Prop. of Main Id.	0.42	0.21	0.48	0.21	0.43	0.21	0.50	0.21	0.42	0.20	0.43	0.22
Word Count	108.94	33.86	111.62	35.17	109.30	34.78	115.10	34.40	107.69	30.69	99.57	35.39
Accuracy	2.92	0.79	2.94	0.73	2.88	0.82	2.98	0.72	3.04	0.68	2.82	0.74
Paraphrasing	0.76	0.43	0.67	0.47	0.74	0.44	0.64	0.48	0.84	0.37	0.76	0.43
Conventions	2.92	0.80	2.90	0.78	2.90	0.80	2.88	0.80	3.00	0.82	2.97	0.72
ND Reading Test												
Total scale score	185.66	18.27	184.31	20.67	185.89	18.64	183.65	21.22	184.90	17.03	186.56	18.62

Note. Sci. Sum.Test = Science Summarization Test; Prop. of main id. = Proportion of main ideas. Proportion of main ideas scores are in proportion form, counterbalanced. Maximum values for science summarization variables: accuracy = 4, conventions = 4, paraphrasing = 1. ND Reading Test = Nelson-Denny reading test. Sample sizes vary based on group and assessment measure. Total sample ($n = 317$, $n = 299$); intervention group ($n = 245$, $n = 232$); comparison group ($n = 72$, $n = 67$).

Table 4

Experiment 1: Summary of Hierarchical Regression Analyses Predicting Intervention Participants' Science Summarization Posttest Scores, Controlling for Pretest Scores, Site of Intervention, and Student Background Characteristics (n = 294)

	Proportion of Main Ideas			Number of Words			Accuracy			Conventions		
Variables	***B***	***SE B***	**β**	***B***	***SE B***	**β**	***B***	***SE B***	**β**	***B***	***SE B***	**β**
Step 1												
Pretest	0.30***	0.05	0.31	0.25***	0.06	0.25	0.22***	0.06	0.22	0.35***	0.06	0.35
Site	0.28**	0.11	0.14	0.08	0.12	0.04	−0.20	0.12	−0.09	0.01	0.12	0.01
SK	0.04	0.02	0.09									
Female	0.38***	0.11	0.19	0.38***	0.11	0.19						
18 and younger										0.11	0.12	0.05
0 remedial credits										0.61**	0.24	0.15
SII										−0.01	0.01	−0.04
Step 2												
Pretest	0.30***	0.05	0.31	0.25***	0.06	0.25	0.23***	0.06	0.23	0.35***	0.06	0.35
Site	0.29**	0.11	0.14	0.08	0.12	0.04	−0.20	0.12	−0.10	0.01	0.12	0.01
SK	0.03	0.02	0.08									
Female	0.37***	0.11	0.19	0.38***	0.11	0.19						
18 and younger										0.11	0.12	0.05
0 remedial credits										0.61**	0.24	0.15
SII										−0.01	0.01	−0.04
Intervention	**0.34****	**0.13**	**0.14**	**0.42****	**0.13**	**0.17**	**0.26***	**0.14**	**0.11**	**−0.03**	**0.13**	**−0.01**

(**Table 4** *continued on following page*)

Table 4 *continued*

Experiment 1: Summary of Hierarchical Regression Analyses Predicting Intervention Participants' Science Summarization Posttest Scores, Controlling for Pretest Scores, Site of Intervention, and Student Background Characteristics (n = 294)

Note. $\Delta R^2 = 0.18$ for Step 1 for proportion of main ideas ($p < .001$), $\Delta R^2 = 0.10$ for Step 1 for number of words ($p < .001$), $\Delta R^2 = 0.05$ for Step 1 for accuracy ($p < .001$), and $\Delta R^2 = 0.18$ for Step 1 for conventions ($p < .001$); $\Delta R^2 = 0.02$ for Step 2 for proportion of main ideas ($p < .01$), $\Delta R^2 = 0.03$ for Step 2 for number of words ($p < .01$), $\Delta R^2 = 0.01$ for Step 2 for accuracy ($p < .05$), and $\Delta R^2 = 0.00$ for Step 2 for conventions *ns*; $\Delta R^2 = 0.001$ for Step 3 for conventions *ns*; $R^2 = 0.21$ for Step 2 for proportion of main ideas ($p < .001$), $R^2 = 0.13$ for Step 2 for number of words ($p < .001$), $R^2 = 0.06$ for Step 2 for accuracy score ($p < .001$), and $R^2 = 0.18$ for Step 3 for conventions ($p < .001$). Students not receiving intervention are the comparison group. SII = Science Interest Inventory. SK = *Science Knowledge Test. Female students are compared to male* students (comparison group). Site compares students at College 1 to College 2 (comparison group). Students with zero previous remedial credits are compared to students with one or more previous remedial credits (comparison group). *Students 18 years old and younger are* compared to students 19 years and older (comparison group).

** $p < .01$.

*** $p < .001$.

Table 5
Experiment 2: Unadjusted Pre- and Posttest Scores

	Total Sample				Science Text Condition				Generic Text Condition				Comparison Group			
	Pretest		Posttest		Pretest		Posttest		Pretest		Posttest		Pretest		Posttest	
Measure	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Sci. Sum. Test																
Prop. of Main Id.	0.39	0.18	0.46	0.23	0.41	0.19	0.52	0.22	0.40	0.19	0.48	0.22	0.33	0.15	0.32	0.21
Word Count	106.05	35.62	108.60	41.65	108.21	34.22	117.43	39.72	109.57	38.17	115.03	35.62	95.40	31.85	79.84	43.78
Accuracy	2.90	0.66	3.06	0.63	2.99	0.68	3.22	0.63	2.90	0.61	3.01	0.54	2.74	0.69	2.86	0.71
Paraphrasing	0.83	0.38	0.69	0.46	0.78	0.42	0.57	0.50	0.83	0.38	0.74	0.44	0.91	0.29	0.84	0.37
Conventions	2.86	0.83	2.82	0.84	2.77	0.88	2.77	0.79	2.85	0.81	2.66	0.84	3.07	0.71	3.22	0.82
ND Reading Test																
Total scale score	181.11	21.22	185.87	22.36	183.19	20.89	185.81	21.31	182.09	21.55	188.19	21.85	176.06	21.11	181.96	24.83

Note. Sci. Sum. Test = Science Summarization Test; Prop. of main id. = Proportion of main ideas. The proportion of main ideas scores are in proportion form, counterbalanced. Maximum values for Science Summarization Variables: Accuracy = 4, Conventions = 4, Paraphrasing = 1. ND Reading Test = Nelson–Denny Reading Test Sample sizes vary based on group and assessment measure. Total Sample ND Reading Test (n = 219); Science Text Condition (n = 85); Generic Text Condition (n = 85); Comparison Group (n = 49). Total Sample Science Summarization Test (n = 199); Science Text Condition (n = 82); Generic Text Condition; (n = 77); Comparison Group (n = 40).

Table 6

Experiment 2: Intervention vs. Comparison Group. Summary of Hierarchical Regression Analyses Predicting Intervention Participants' Science Summarization Posttest Scores, Controlling for Pretest Scores and Student Background Characteristics (n = 205)

	Proportion of Main Ideas			Number of Words			Accuracy			Conventions		
Variables	***B***	***SE B***	**β**	***B***	***SE B***	**β**	***B***	***SE B***	**β**	***B***	***SE B***	**β**
Step 1												
Pretest	0.45***	0.06	0.45	0.41***	0.06	0.41	0.32***	0.07	0.32	0.35***	0.06	0.35
Site	0.33*	0.14	0.16	0.46***	0.13	0.23	0.22	0.14	0.11	0.15	0.17	0.07
SII										−0.03**	0.01	−0.17
Female	0.15	0.12	0.07									
0 remedial credits										0.45**	0.15	0.22
Asian	0.50**	0.19	0.17							−0.52**	0.20	−0.18
White	0.13	0.17	0.05							−0.08	0.17	−0.03
Black	0.00	0.18	0.00							−0.40*	0.18	−0.17
Other race	−0.58**	0.22	−0.17							0.25	0.23	0.07
Full time	0.21	0.13	0.10	0.21	0.14	0.10						
US Citizen										0.29	0.16	0.12
Step 2												
Pretest	0.42***	0.06	0.42	0.37***	0.06	0.37	0.29***	0.07	0.29	0.33***	0.06	0.33
Site	0.33*	0.14	0.16	0.46***	0.13	0.23	0.20	0.14	0.10	0.16	0.17	0.08
SII										−0.03**	0.01	−0.16
Female	0.15	0.12	0.07									

(**Table 6** *continued on following page*)

Table 6 *continued*

Experiment 2: Intervention vs. Comparison Group. Summary of Hierarchical Regression Analyses Predicting Intervention Participants' Science Summarization Posttest Scores, Controlling for Pretest Scores and Student Background Characteristics (n = 205)

	Proportion of Main Ideas			Number of Words			Accuracy			Conventions		
Variables	***B***	***SE B***	**β**	***B***	***SE B***	**β**	***B***	***SE B***	**β**	***B***	***SE B***	**β**
0 remedial credits										0.44**	0.15	0.21
Asian	0.47**	0.18	0.16							−0.48*	0.20	−0.17
White	0.03	0.16	0.01							−0.08	0.17	−0.04
Black	−0.04	0.17	−0.02							−0.38*	0.18	−0.16
Other race	−0.63**	0.21	−0.19							0.21	0.23	0.06
Full time	0.15	0.13	0.08	0.11	0.13	0.06						
US citizen										0.28	0.16	0.12
Science	**0.62*****	**0.16**	**0.31**	**0.70*****	**0.16**	**0.34**	**0.44***	**0.18**	**0.22**	**−0.24**	**0.17**	**−0.12**
Generic	**0.36***	**0.16**	**0.18**	**0.62*****	**0.16**	**0.30**	**0.16**	**0.18**	**0.08**	**−0.39***	**0.17**	**−0.19**

Note. $\Delta R^2 = 0.34$ for Step 1 for proportion of main ideas ($p < .001$), $\Delta R^2 = 0.25$ for Step 1 for number of words ($p < .001$), $\Delta R^2 = 0.12$ for Step 1 for accuracy ($p < .001$), and $\Delta R^2 = 0.31$ for Step 1 for conventions ($p < .001$); $\Delta R^2 = 0.05$ *for Step 2 for proportion of main ideas* ($p < .001$), $\Delta R^2 = 0.07$ for Step 2 for number of words ($p < .001$), $\Delta R^2 = 0.03$ for Step 2 for accuracy ($p < .05$), and $\Delta R^2 = 0.02$ for Step 2 for conventions *ns*; $\Delta R^2 = 0.1$ for Step 2 for conventions ($p < .001$); $R^2 = 0.39$ for Step 2 for proportion of main ideas ($p < .001$), $R^2 = 0.32$ for Step 2 for number of words ($p < .001$), $R^2 = 0.16$ for Step 2 for accuracy score ($p < .001$), and $R^2 = 0.33$ for Step 3 for conventions ($p < .001$). Hispanic students are the uncoded comparison group *for the White, Asian, Black, and Other variables. SII* = Science Interest Inventory. Female students are compared to male students (comparison group). Site compares students at site 2 to site 3 (comparison group). Students with 0 previous remedial credits are compared to students with one or more previous remedial credits (comparison group). Full-time students are compared to part-time students (comparison group). US citizens are compared to non-US citizens (comparison group). Female students are compared to male students (comparison group). * $p < .05$. ** $p < .01$. *** $p < .001$.

Table 7

Experiment 2: Science vs. Generic Text Condition. Summary of Hierarchical Regression Analyses Predicting Science Intervention Participants' Science Summarization Posttest Scores, Controlling for Pretest Scores, Site, and Student Background Characteristics (n = 151)

	Proportion of Main Ideas			Number of Words			Accuracy			Conventions		
Variables	***B***	***SE B***	**β**	***B***	***SE B***	**β**	***B***	***SE B***	**β**	***B***	***SE B***	**β**
Step 1												
Pretest	0.42***	0.07	0.42	0.38***	0.08	0.38	0.21*	0.08	0.20	0.27***	0.08	0.27
Site	0.36*	0.17	0.18	0.44**	0.16	0.22	0.22	0.17	0.11	0.05	0.16	0.03
SII							−0.03	0.02	−0.14	−0.06***	0.01	−0.30
19 and younger										0.20	0.16	0.10
Asian	0.41	0.22	0.15									
White	−0.05	0.19	−0.02									
Black	−0.18	0.21	−0.07									
Other race	−0.93***	0.27	−0.27									
Full time	0.27	0.16	0.13	0.22	0.16	0.11						
US citizen										0.19	0.18	0.08

(**Table 7** *continued on following page*)

Table 7 *continued*

Experiment 2: Science vs. Generic Text Condition. Summary of Hierarchical Regression Analyses Predicting Science Intervention Participants' Science Summarization Posttest Scores, Controlling for Pretest Scores, Site, and Student Background Characteristics (n = 151)

	Proportion of Main Ideas			**Number of Words**			**Accuracy**			**Conventions**		
Variables	***B***	***SE B***	**β**	***B***	***SE B***	**β**	***B***	***SE B***	**β**	***B***	***SE B***	**β**
Step 2												
Pretest	0.41***	0.07	0.41	0.38***	0.08	0.38	0.20*	0.07	0.29	0.27***	0.07	0.27
Site	0.36*	0.16	0.18	0.44**	0.16	0.21	0.21	0.17	0.10	0.05	0.16	0.02
SII							−0.03	0.02	−0.15	−0.06***	0.01	−0.30
19 and younger										0.19	0.16	0.10
Asian	0.43*	0.22	0.16									
White	−0.13	0.19	−0.05									
Black	−0.19	0.20	−0.08									
Other race	−1.00***	0.27	−0.28									
Full time	0.31*	0.15	0.15	0.23	0.16	0.11						
US citizen										0.22	0.18	0.09
Science	**0.32***	**0.14**	**0.16**	**0.11**	**0.15**	**0.05**	**0.33***	**0.16**	**0.16**	**0.19**	**0.15**	**0.10**

(**Table 7** *continued on following page*)

Table 7 *continued*

Experiment 2: Science vs. Generic Text Condition. Summary of Hierarchical Regression Analyses Predicting Science Intervention Participants' Science Summarization Posttest Scores, Controlling for Pretest Scores, Site, and Student Background Characteristics (n = 151)

Note. $\Delta R^2 = 0.32$ for Step 1 for proportion of main ideas ($p < .001$), $\Delta R^2 = 0.21$ for Step 1 for number of words ($p < .001$), $\Delta R^2 = 0.09$ for Step 1 for accuracy ($p < .01$), and $\Delta R^2 = 0.22$ for Step 1 for conventions ($p < .001$); $\Delta R^2 = 0.02$ for Step 2 for proportion of main ideas ($p < .05$), $\Delta R^2 = 0.003$ for Step 2 for number of words *ns*, $\Delta R^2 = 0.03$ for Step 2 for accuracy ($p < .05$), and $\Delta R^2 = 0.01$ for Step 2 for conventions *ns*; $\Delta R^2 = 0.1$ for Step 2 for conventions ($p < .001$); $R^2 = 0.35$ for Step 2 for proportion of main ideas ($p < .001$), $R^2 = 0.21$ for Step 2 for number of words ($p < .001$), $R^2 = 0.12$ for Step 2 for accuracy score ($p < .001$), and $R^2 = 0.23$ for Step 3 for conventions ($p < .001$). Students receiving the generic CCSI intervention are the comparison group. Hispanic students are the uncoded comparison group for the White, Asian, Black, and Other variables. SII = Science Interest Inventory. Female students are compared to male students (comparison group). Site compares students at site 2 to site 3 (comparison group). Students 19 years old and younger are compared to students 20 years old and older (comparison group). Full-time students are compared to part-time students (comparison group). US citizens are compared to non-US citizens (comparison group). * $p < .05$. ** $p < .01$. *** $p < .001$.